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January 25, 2008 CDM Project File: 5000-55353

Ms. Ana Townsend
California Regional Water Quality Control Board - Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, California 90013

Subject: **Addendum No. 2** to the Building 2 In-Situ Reactive Zone Pilot Test Workplan
C-Sand Bioremediation Amendment Injections
Former C-6 Facility, 19503 South Normandie Avenue, Los Angeles, California
Compliance File CI-9310, Order No. R4-2007-0040

Dear Ms. Townsend:

On behalf of Boeing Corporate Real Estate (CRE) (formerly Boeing Realty Corporation), Camp Dresser & McKee Inc. (CDM) has prepared this Addendum to the Building 2 In-Situ Reactive Zone Pilot Test Workplan (Work Plan) (ARCADIS G&M, Inc., August 15, 2001) to perform bioremediation amendment slug injections in C-Sand at the Building 2 Area of the former C-6 facility. The original Work Plan was approved by the California Regional Water Quality Control Board Los Angeles Region (RWQCB) on May 17, 2002. An addendum (Addendum No. 1) to the Work Plan (ARCADIS G&M, Inc., July 31, 2002) was prepared to incorporate the C-Sand into the in situ reactive zone (IRZ) pilot test and was subsequently approved by RWQCB on November 6, 2002.

This Addendum modifies and supplements the original plan and Addendum No. 1 based on the results of the previous slug injections by proposing additional electron donor injections and bioaugmentation to enhance the biodegradation (reductive dechlorination) process and reduce contaminant mass.

1.0 Project Background

The former C-6 facility is located at the southeast corner of Normandie Avenue and Knox Street in Los Angeles, California (Figure 1). Two volatile organic compound (VOC) groundwater plumes have been identified at the former C-6 facility (former Buildings 2 and 1/36). This document covers only former Building 2. A biorecirculation pilot test is being conducted at the Building 1/36 area of the facility as described in the CDM document titled "Addendum to Building 1/36 (Parcel C) Source-Area Groundwater In-Situ Reactive Zone

Pilot Study Workplan" (CDM, February 1, 2007). The former Building 2 primary VOCs include trichloroethylene (TCE) and 1,1-dichloroethene (1,1,-DCE). Other VOCs are present but at lower concentrations.

Based on the Work Plan and Addendum No. 1, the RWQCB issued a General Waste Discharge Requirement (General WDR) permit in February 2003. Infrastructure including injection (or amendment) wells and piping were installed between May and September 2003 in Building 2 (Building 2 Amendment and Monitoring Well Installation Report, ARCADIS G&M, Inc., July 28, 2004). In general, the injection well network was designed to treat TCE concentrations in excess of 5 milligrams per liter (mg/l) in the C-Sand groundwater beneath the source areas. Amendment injections were conducted at the Building 2 area in 2004; however, technical difficulties prompted a review of the selected amendment and injection methods. A final report summarizing the results of bioremediation amendment injections and evaluation of the groundwater monitoring data collected over a 4-year period (2004 to 2007) at the Building 2 Area was submitted to RWQCB in March 2007 (CDM, Final Report of In-Situ Reactive Zone Pilot Test at Former Building 2, March 29, 2007). These data indicated that, although limited injections were performed, reductive dechlorination of TCE did occur in some of the injection well locations in both B-Sand and C-Sand. Where reductive dechlorination occurred, degradation products consisted of cis-1,2-DCE, vinyl chloride (VC), and some ethene. The data also indicated that C-Sand wells in the Building 2 area showed the most promising results in terms of biodegradation. As a result, additional bioremediation injections appear to be warranted in C-Sand.

In June 2007, the RWQCB rescinded the General WDR Permit for former Building 2, which was then replaced with a Site-Specific (Individual) WDR Permit issued in August 2007. The Individual WDR permit was issued to cover bioremediation (biorecirculation and/or slug injections) at the entire C-6 facility as appropriate, with specific approval for conducting a biorecirculation pilot study at Building 1/36. The Permit also provided options to continue or expand the biorecirculation study and/or implement slug injections at portions or all of the C-6 facility as appropriate, following preparation of work plans and approval of the same by the RWQCB.

This Addendum has therefore been prepared for the C-Sand at the Building 2 area (herein referred to as the Site) to implement: additional injections of electron donor in the existing C-Sand wells to maintain/enhance conditions supportive of biodegradation; and bioaugmentation in order to enhance the biodegradation (dechlorination) of contaminants. The specific wells and infrastructure proposed herein performed well without significant technical difficulties during prior use.

2.0 Slug Injection Objectives

The main objective of the C-Sand amendment injections is to verify the effectiveness of bioremediation with bioaugmentation to further reduce VOC concentrations and mass in groundwater beneath the Site and enhance the reductive dechlorination process. The specific objectives of the injection program are as follows:

- Continue and enhance mass destruction in the C-sand including destruction of sorbed contamination that would otherwise act as a long-term residual source;
- Provide field validation of the ability of bioaugmentation culture (SDC-9™ dechlorinating culture) to enhance dechlorination of chlorinated ethenes; and
- Provide a treatment zone where the dechlorinating culture can quickly become established under Site conditions.

3.0 Slug Injection Scope

This section describes the scope of the injections, including a brief description of the technology, the overall approach including a brief description of the injection plan and system, measures of success, and the monitoring program. Figure 2 shows the overall existing plan for the Site including existing C-Sand amendment wells and C-Sand groundwater monitoring wells of interest. Figure 3 is a focused plan showing the area of the Site where the existing C-Sand amendment wells are located. These wells are manifolded to single aboveground vault (Vault 4) as shown on Figure 3.

3.1 Technology Description

Bioremediation is a groundwater remediation technology that stimulates the in-situ biological destruction of chlorinated VOCs over a wide range of concentrations in groundwater, including sorbed contaminants. It involves the addition of substrates and nutrients to an aquifer to stimulate the growth of a target consortium of bacteria, ultimately resulting in reductive dechlorination of chlorinated solvents. In cases where the appropriate bacterial populations are not present in an aquifer, it can also involve the addition of a bacterial culture that is highly efficient at degrading a particular contaminant, which is known as bioaugmentation. Bioremediation is used when it is desired to increase the rate of intrinsic contaminant biotransformation, which may be limited by lack of required nutrients, electron donor, or by the lack of appropriate bacteria. For chlorinated solvents, this process occurs most favorably under strongly reducing (i.e., methanogenic) conditions created by addition of electron donor compounds (generally fermentable organic compounds such as carbohydrates).

3.2 Proposed Overall Approach

An electron donor laboratory treatability study ((CDM, Pre-Remediation Activities Documentation Report September 30, 2007) was previously conducted to determine the optimal combination of electron donors and bioaugmentation cultures for the C-6 Facility. The results of the study showed that either sodium lactate (fast release donor) or emulsified vegetable oil (slow release donor), in combination with commercially available bioaugmentation cultures, were best suited for slug injection application at the Site. However, other donors studied and tested also performed reasonably well. While it is planned to initially use sodium lactate for these injections, any of the other tested donors as well as the bioaugmentation cultures (which are all approved for use at the Site under the Individual WDR Permit) may be used either in lieu of or in conjucntion with sodium lactate.

The overal approach consists of performing an initial round of slug injections into the existing C-Sand amendment wells using sodium lactate solution and bioaugmentation . Based on performance monitoring data, additional rounds of donor injection may be necessary to achieve the objectives stated previously. Baseline monitoring will be performed prior to injection, and periodic performance monitoring will be conducted at up to six existing monitoring wells near the Vault 4 injection area. Details on the locations, frequency, and analytes are provided in Section 4.

3.3 Slug Injection Plan

The 20 C-Sand injection wells in Vault 4 (Figures 2 and 3) are in rows oriented approximately perpendicular to predominant C-Sand groundwater flow, with wells within an individual row spaced approximately 30 feet apart, and the rows being spaced approximately 45 feet apart. Table 1 provides the well construction details for the 20 C-Sand amendment wells. The injections will be designed to achieve an appropriate radius of influence around each well during the injection. The injection concentration is expected to be in the range of 0.5% up to 10% donor solution, which is sufficiently high to degrade residual source material or sorbed mass that may be present.

It is expected that 19 of the 20 existing Vault 4 wells will be used for injection. One well is unusable based on the last injection conducted in 2004. The injections will be closely monitored for volumes, pressures, and allowable flowrates, and any wells that build up pressure to unacceptable levels will have flow rates decreased, or potentially have injections stopped.

Bioaugmentation will be performed at the Site so that a culture capable of efficient transformation of contaminants to ethene is available and adapted to Site-specific conditions. Appropriate amounts of bioaugmentation culture will be added to some or all of the injection wells to meet the objectives identified in Section 2..

3.4 Slug Injection System

Based on analysis of previous injection data, it is estimated that the average sustainable effective injection flow rate will range from approximately 1 to 10 gallons per minute (gpm) per well for the wells selected at Vault 4. Actual individual well flowrates may be higher or lower and will be documented during the field activities. It is anticipated that the previously-used injection manifold will be adequate to control flow into the wells. However, the injection system will include automatic pressure control, so that flow will be discontinued if the injection pressure exceeds a predetermined limit. This approach is intended to allow injection only under siphoning conditions after the line is primed. The injection system details will be determined following approval of this plan.

The make-up water source will be from one or more fire hydrants located adjacent to the Site. Water will be mixed with sodium lactate or other approved electron donors using a mechanical dosing system that adds donor based on flow proportioning. For bioaugmentation the diluted electron donor solution will be stored in a closed-top tank prior to mixture with culture to minimize further introduction of oxygen. Proper measures will be taken to reduce residual chlorine and dissolved oxygen present in the hydrant water.

A tracer such as bromide may be added to the injected water in order to improve understanding of the local hydraulics. If a tracer test is performed, monitoring for the tracer will be performed either using downhole probes or by collecting groundwater samples and analyzing them for the tracer.

3.5 Measures of Success

During and following the injection, data will be collected and analyzed to determine if the slug injections are performing as intended. Metrics, similar to those described in the Work Plan and Addendum No. 1, will be used to evaluate the pilot system and will include: measurement of VOC concentrations, electron donor parameters, redox-sensitive parameters, biological activity parameters, and water quality parameters in groundwater; and measurement of injection flows and pressure to confirm siphoning conditions and desired injection flow rates and volumes. These data will be used to determine whether each of the objectives listed in Section 2 has been achieved. Further information regarding monitoring is

presented within Section 4, and more information on data interpretation and reporting is provided in Section 5.

4.0 Monitoring and Reporting

Periodic monitoring will be conducted from up to six existing C-Sand monitoring wells located near the Vault 4 injection area. Table 2 provides the well completion details of the six existing monitoring wells, which consiste of:

- IRZCMW001 to monitor upgradient conditions;
- CMW026, IRZCMW002, IRZCMW003, and MWC024 to monitor the aquifer in areas expected to be directly impacted by injections; and
- CMW002 to monitor conditions downgradient of the injection area (to determine when effects of the injections appear).

Monitoring to be performed in support of the slug injections has been incorporated into a revised Monitoring and Reporting Program (MRP) No. CI-9310 from the Individual WDR Permit which has been amended to include the Building 2 C-Sand slug injections. The MRP is being submitted under a separate cover to RWQCB.

4.1 Baseline Monitoring

Baseline sampling is recommended prior to beginning injection activities in order to establish baseline conditions as close as possible to the injection activities.

At least one round of baseline monitoring will be performed prior to the slug injection and will include one or more of the following analysis:

- VOCs and degradation products consisting of tetrachloroethene (PCE), TCE, 1,1-DCE, cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-dicholorethylene (trans-1,2-DCE), vinyl chloride (VC), ethene, ethane, and chloride;
- Electron donor parameters (chemical oxygen demand [COD] or total organic carbon [TOC]);
- Redox sensitive parameters (dissolved oxygen [DO], oxidation-reduction potential [ORP], ferrous iron, sulfate, and methane);
- Bioactivity parameters (alkalinity and pH);

- Bacterial DNA analysis by Quantitative Polymerase Chain Reaction test (qPCR) to identify the amount of indigenous *Dehalococcoides spp.* strains; and
- Other water quality indicators (temperature, and electrical conductivity [EC]).

4.2 Performance Monitoring

Performance monitoring will be performed periodically following the initial slug injection to confirm the effectiveness of the injections, and to determine if and when subsequent injections are needed. The monitoring will consist of groundwater sampling from the network of monitoring wells listed above.

The frequency of performance monitoring and reporting is provided in the revised MRP No. CI-9310. If additional injection events are conducted, monitoring may need to be modified as appropriate and a revised MRP will be submitted.

4.3 Sampling and Analysis

In general, the same sampling and analysis procedures specified in the original Work Plan will be followed (ARCADIS, 2001).

A combination of field measurements and fixed laboratory analyses will be used during WDR monitoring. A multi-parameter water quality instrument will be used to measure purge parameters (pH, DO, ORP, temperature, and EC). A field test kit will be used for ferrous iron, and test kits may be used for other parameters (e.g. alkalinity, and sulfate). All remaining analyses will be performed by a fixed laboratory (VOCs, ethene/ethane/methane, anions, COD/TOC, and qPCR).

All samples for fixed laboratory analysis will be stored on ice in a cooler and transported by courier to a California-certified analytical laboratory for analysis under proper chain-of-custody protocols. Chain-of-custody forms will be maintained throughout sample collection and transport. Field data will be collected and recorded on standard groundwater monitoring forms, and the laboratory data will be submitted electronically for upload to the project database in accordance with the accordance with Boeing's Data Management Plan (DMP).

Duplicate samples will be collected at a frequency of 5% (one every 20 samples) as a check on sample homogeneity and laboratory precision. Trip blanks will be sent with each shipment of VOC and ethene/ethane/methane samples as a check for contamination during transport. Approximately 10 percent of the VOC laboratory data for the primary samples will be validated during each sampling round to verify that the data are of sufficient quality.

4.4 Data Evaluation and Reporting

Data evaluation will be performed as injection events and groundwater monitoring events are completed. Performance monitoring data will be evaluated following each sampling round and regular progress reports will be prepared as provided in the revised MRP.

At the conclusion of this injection and monitoring program, a final summary report will be prepared per the revised MRP that documents the slug injection activities performed including monitoring and sampling results, provides data evaluation/interpretation, and presents conclusions about the injections and recommendations for future actions.

5.0 Project Schedule

It is estimated that implementation of the initial round of slug injections will be completed by the second quarter of 2008, pending approval of this addendum and the revised MRP. Baseline monitoring and subsequent performance monitoring and reporting will be conducted at regular intervals as described in the revised MRP. Schedule for additional injections, if needed, will be based on the results of the performance monitoring. The final summary report is expected to be submitted to RWQCB by October 30, 2010.

6.0 Residuals Management

Residuals generated during the implementation of the slug injections will include groundwater monitoring and purge water. All groundwater monitoring and purge water will be contained in 55-gallon drums and labeled. The drums will all be stored in a common area of the Site designated by CRE. Upon completion of field activities, the 55-gallon drums will be characterized for proper off-Site disposition by CRE.

7.0 Health and Safety

During Site operations, all personnel will follow procedures and safeguards which will be described in an Addendum to the existing site-specific Health and Safety Plan (HSP, CDM, May 4, 2006) and prepared in accordance with Title 29 CFR, Section 1910.120 and 8 CCR 5192. The HSP Addendum will assign responsibilities, establish personnel protection standards and mandatory safety procedures, and specify appropriate measures and procedures taken for contingencies that may arise while operations are being conducted at the site. The HSP Addendum will be specific to the slug injection activities at the Site.

Please do not hesitate to contact the undersigned at 949-752-5452, if you have any questions.

Very truly yours,

Ravi Subramanian

Ravi Subramanian, P.E
Principal

Attachments

Figure 1 -	Site Vicinity Map
Figure 2 –	Location Map, C-Sand Wells of Interest - Former Building 2
Figure 3 -	Amendment and Monitoring Well Layout, Proposed C-Sand Slug Injections at Vault 4 - Former Building 2
Table 1 –	Well Completion Details - Existing C-Sand Amendment Wells, Proposed C-Sand Slug Injections at Vault 4, Former Building 2
Table 2 –	Well Completion Details - Existing C-Sand Monitoring Wells of Interest, Proposed C-Sand Slug Injections at Vault 4, Former Building 2

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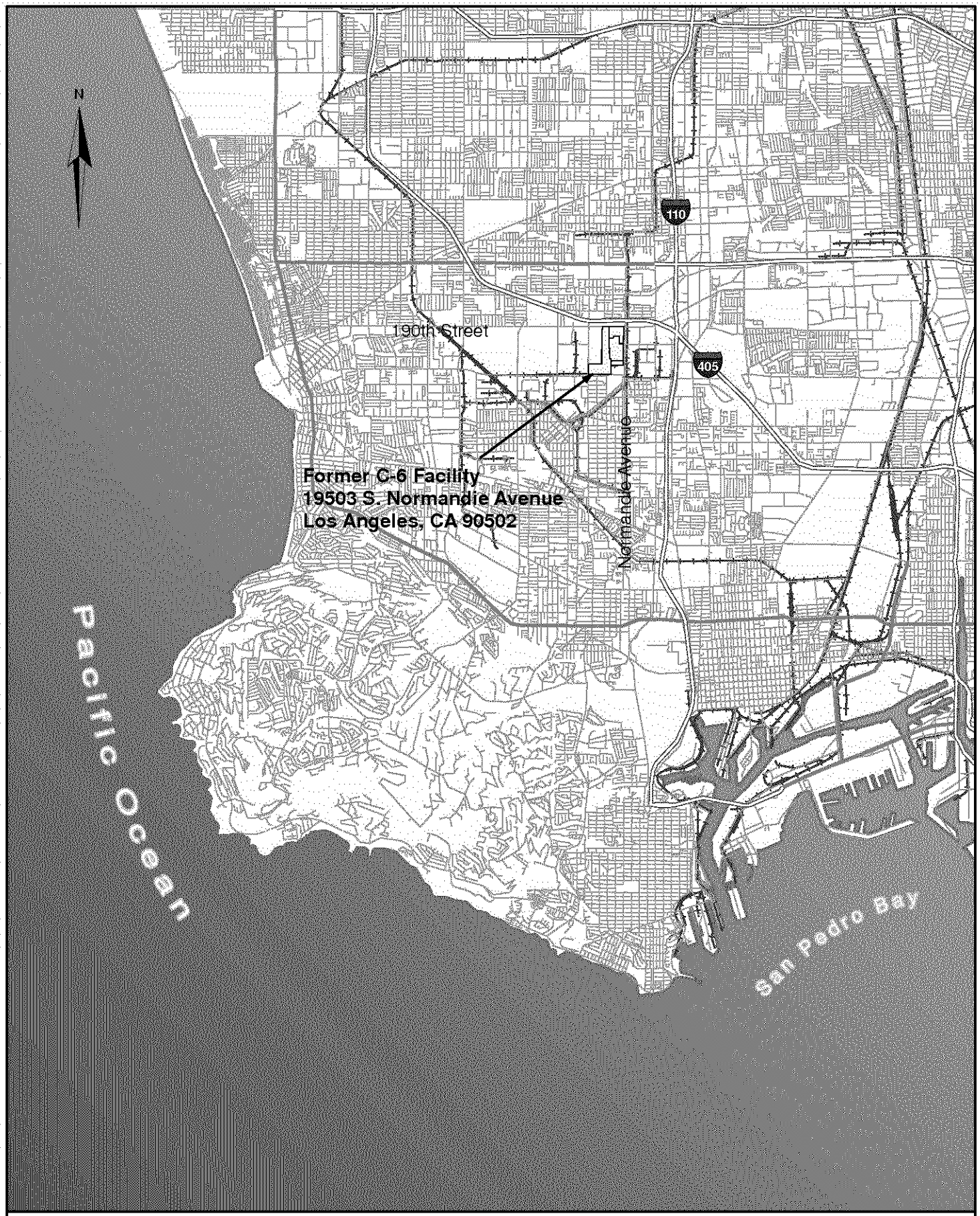

January 21, 2008

Boeing Corporate Real Estate
Former C-6 Facility

Site Vicinity Map

Figure 1

Legend

Former C-6 Facility

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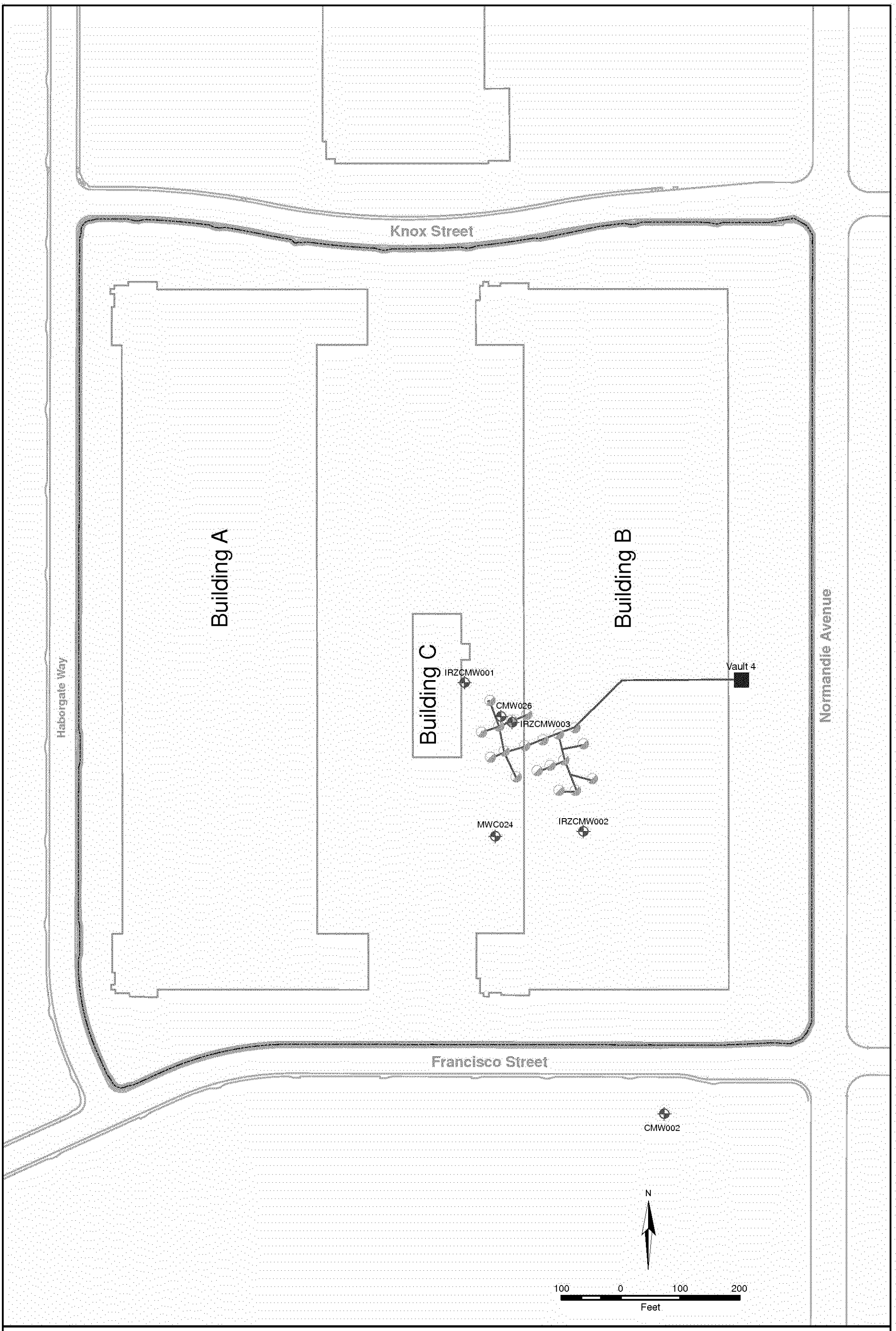

January 13, 2008

Legend

- Vault
- Existing C-Sand Monitoring Well
- Existing C-Sand Injection Wells
- Underground Pipeline
- Site Boundary

CDM

Figure 2

Boeing Corporate Real Estate
Former C-6 Facility

Location Map
C-Sand Wells of Interest
Former Building 2

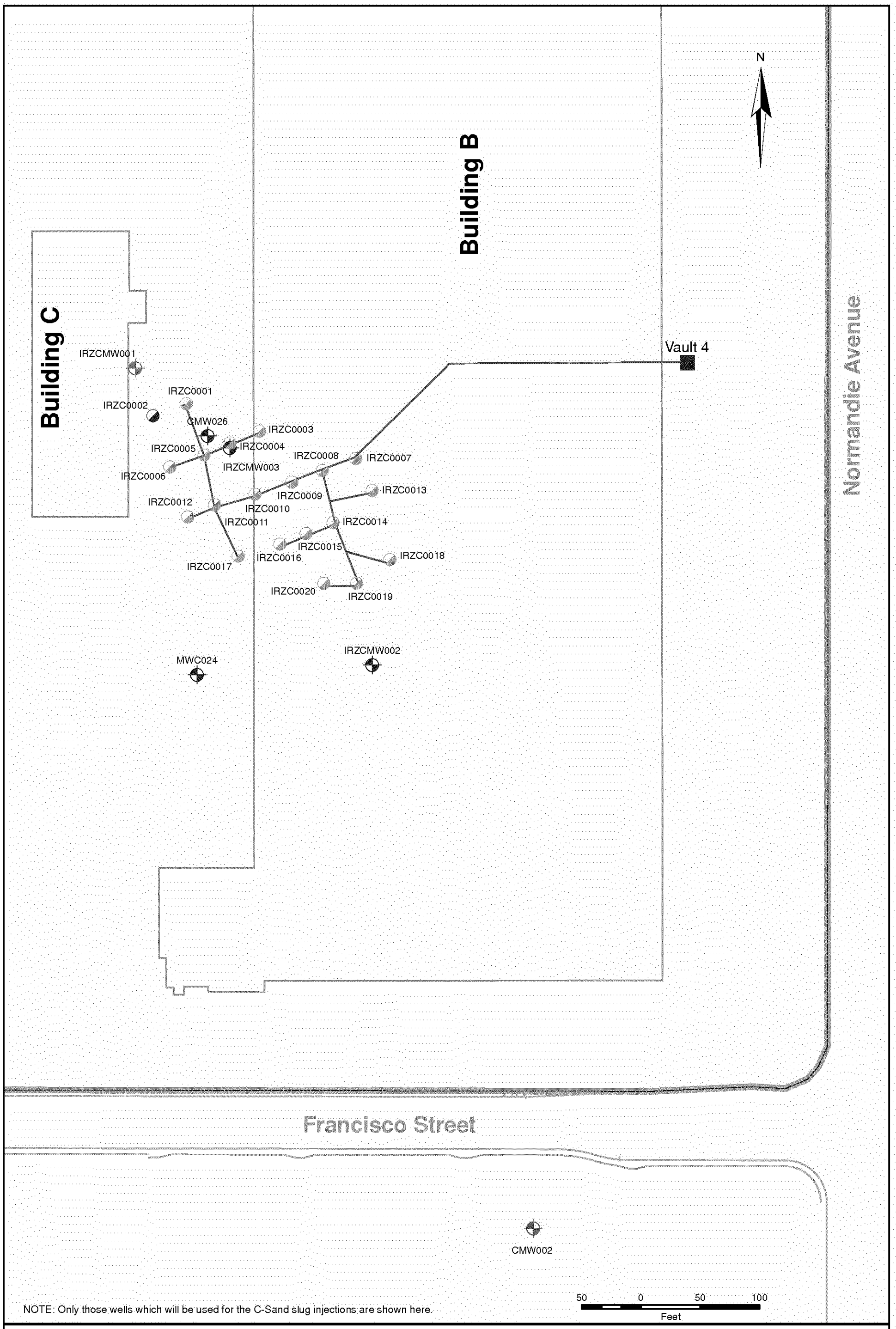

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Table 1
Well Completion Details - Existing C-Sand Amendment Wells
Proposed C-Sand Slug Injections at Vault 4, Former Building 2
Former C-6 Facility, Los Angeles, CA

Well ID	Northing	Easting	Top Of Casing Elev - ft. MSL	Well Diameter - in.	Bentonite Seal - ft. bgs		Sand Filter Pack (8-in dia) - ft. bgs		Screen Interval (0.01 in Slot Size) - ft. bgs		Screen Thickness ft.
IRZC0001	6,470,257	1,768,637	48.05	1.5	80	91	91	117.5	92.5	117.5	25
IRZC0002	6,470,229	1,768,627	48.76	1.5	90	91.5	91.5	118	93	118	25
IRZC0003	6,470,319	1,768,614	49.21	1.5	80	91	91	117.5	92.5	117.5	25
IRZC0004	6,470,294	1,768,604	48.59	1.5	80	91.5	91.5	117.5	92.5	117.5	25
IRZC0005	6,470,272	1,768,594	48.88	1.5	80	90	90	116.5	91.5	116.5	25
IRZC0006	6,470,243	1,768,584	48.32	1.5	80	90	90	116.5	91.5	116.5	25
IRZC0007	6,470,400	1,768,591	53.23	1.5	84	95	95	121	96	121	25
IRZC0008	6,470,372	1,768,581	53.22	1.5	84	95	95	121	96	121	25
IRZC0009	6,470,346	1,768,571	53.22	1.5	87.5	98.5	98.5	124.5	99.5	124.5	25
IRZC0010	6,470,315	1,768,561	49.1	1.5	81	91.5	91.5	117.5	92.5	117.5	25
IRZC0011	6,470,281	1,768,552	48.74	1.5	90.5	92	92	118	93	118	25
IRZC0012	6,470,258	1,768,542	48.27	1.5	80	91	91	117	93	117	24
IRZC0013	6,470,414	1,768,564	53.21	1.5	84.5	94	94	120	95	120	25
IRZC0014	6,470,381	1,768,537	53.22	1.5	85.5	94	94	120	95	120	25
IRZC0015	6,470,358	1,768,528	53.22	1.5	84.5	95.5	95.5	121.5	96.5	121.5	25
IRZC0016	6,470,336	1,768,519	53.23	1.5	89	99.5	99.5	124.5	100.5	124.5	24
IRZC0017	6,470,301	1,768,509	48.8	1.5	81	90	90	116	91	116	25
IRZC0018	6,470,429	1,768,506	53.25	1.5	87.5	98.5	98.5	124.5	99.5	124.5	25
IRZC0019	6,470,401	1,768,486	53.25	1.5	84.5	94	94	120	95	120	25
IRZC0020	6,470,373	1,768,486	53.05	1.5	87.5	98.5	98.5	124.5	99.5	124.5	25

= Indicates that the well was subsequently abandoned

Table 2
Well Completion Details - Existing C-Sand Monitoring Wells of Interest
Proposed C-Sand Slug Injections at Vault 4, Former Building 2
Former C-6 Facility, Los Angeles, CA

Well I.D.	Easting[1,3]	Northing[1, 3]	Reference Elevation (ft AMSL)[2]	Boring Total Depth (feet)	Screen Depth Interval (feet)	Depth to Top of Filter Pack (feet)	Casing Diameter (inches)	Casing Type	Slot Size (inches)	Drilled Date
IRZCMW001	1,768,660	6,470,218	51.74	-	92-117	90	4	Sch 40 PVC	0.01	8/6/2003
IRZCMW002	1,768,410	6,470,417	55.6	-	96-121	94	4	Sch 40 PVC	0.01	5/12/2004
IRZCMW003	1,768,593	6,470,298	51.69	-	92-117	90	4	Sch 40 PVC	0.01	8/8/2003
CMW0002	1,767,936	6,470,554	52.81	124	99-124	97	4	Sch 40 PVC	0.01	8/14/2003
CMW026	1,768,603	6,470,279	51.53	117	92-117	90	4	Sch 40 PVC	0.01	8/6/2003
MWC024	1,768,409	6,470,266	51.64	125	96-121	93	4	Sch 80 PVC	0.02	10/26/2006

[1] California State Plane North American Datum of 83 (NAD 83), Zone 5, Feet
[2] ft AMSL - Feet Above Mean Sea Level. Elevations based on North American Vertical Datum of 1988 (NAVD 88)
[3] Coordinates were slightly revised based on additional survey done in November 2006